Cave survey yields a new spider family record for Israel

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doi: 10.5431/aramit5105

Abstract. Leptonetidae and Phyxelididae were discovered as part of the first thorough cave survey of arthropods in Israel, and are reported here for the first time from caves in Israel. Both families were found in relatively temperate and humid caves at the western part of Israel and in intermediate elevation, at the cave entrance and the twilight zone. Leptonetidae were recorded for the first time in Israel.

Keywords: Araneae, *Cataleptoneta*, Leptonetidae, Levant, *Phyxelida*, Phyxelididae, troglophiles

Cave dwelling species can be classified into three groups, according to their affinity to life in caves: troglobites are obligatory cave species, and therefore usually have morphological adaptations such as reduction or complete loss of vision and pigmentation as well as elongation of the appendages; troglophiles (which can be divided into eutroglophile and subtroglophile, see Sket 2008) are species that have a strong affinity to caves but can also live outside caves, and therefore lack these morphological adaptations. A third group of cave dwellers are the trogloxenes, species that live in caves but are required to leave the cave periodically for various needs (Trajano 2005, Sket 2008). Spiders include nearly 1000 true troglobite species, and many more species are troglophiles and can be found at the entrances of caves (Reddell 2005, Romero 2009).

Leptonetidae Simon, 1890, is one example of a spider family with both troglobite and troglophile species (Ledford 2004, Jocqué & Dippenaar-Schoeman 2006, Ledford et al. 2011). Leptonetids are small six-eyed haplogyne spiders that construct sheetwebs. Thirteen of the 22 recognized leptonetid genera have a Palearctic distribution, and many of the species are associated with caves (Deltshev 1985, Ledford 2004, Jocqué & Dippenaar-Schoeman 2006, Ledford et al. 2011, Deltshev et al. 2014, World Spider Catalog 2015). Phyxelididae Lehtinen, 1967 is mainly an Afrotropical family of small-medium cribellate eight-eyed spiders. Species belonging to this family build tangled webs or sheetwebs and many of the 14 known genera are found in dark places (Griswold 1990, Jocqué & Dippenaar-Schoeman 2006). Of the 272 leptonetid species and the 64 phyxelidid species known worldwide only one of each of these families was previously recorded from the Levant sensu stricto (World Spider Catalog 2015). *Cataleptoneta edentula* Denis, 1955 was described from a cave in Lebanon (Denis 1955) and *Phyxelida anatolica* Griswold, 1990 was described from a cave in Southern Turkey (close to Syria) and was later recorded under stones in a pine forest in the Cyprus mountains (Griswold 1990, Thaler & Knoflach 1998, World Spider Catalog 2015).

The Levant is a historical and geographical term used for the lands at the eastern edge of the Mediterranean Sea (Por 1975), and as such, has many definitions of its specific limits. Here we use the Levant 'sensu stricto', namely the island of Cyprus and the mainland area including Israel, Jordan, Lebanon, Palestine and Syria. The Levant mainland is, as a unit, unusually heterogeneous topographically, climatically and biologically. It includes four main topographic elements, each element continues from the north to the south: the coastal plain, the western mountain ridge, the rift valley and the eastern mountain ridge. The topographic and climatic heterogeneity can be explained by geological processes and the crossing of horizontal zonal climatic belts by these four topographic elements (Por 1975, Danin 1988). Israel has se-

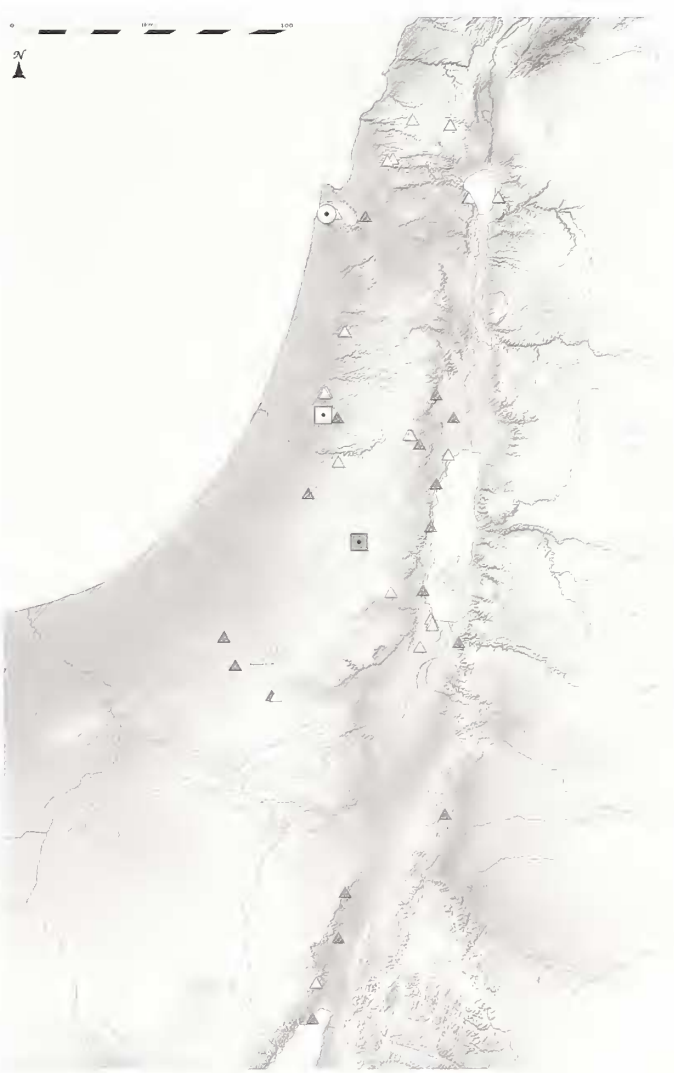

Fig. 1: Geographic-topographic representation of the surveyed sites. Locality of Leptonetidae marked with a circle, localities of Phyxelididae marked with squares, all other sampling localities marked with triangles. Caves with specific environmental records (33) marked in yellow/light grey, other sites (22) marked in purple/dark grey (adapted from Aharon 2015, based on Eric Gaba – http://commons.wikimedia.org/wiki/User:Sting)

This contribution was presented at the 29th European Congress of Arachnology, Brno, 2015 August 24-28.

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submitted 29.10.2015, accepted 21.12.2015, online 5.2.2016

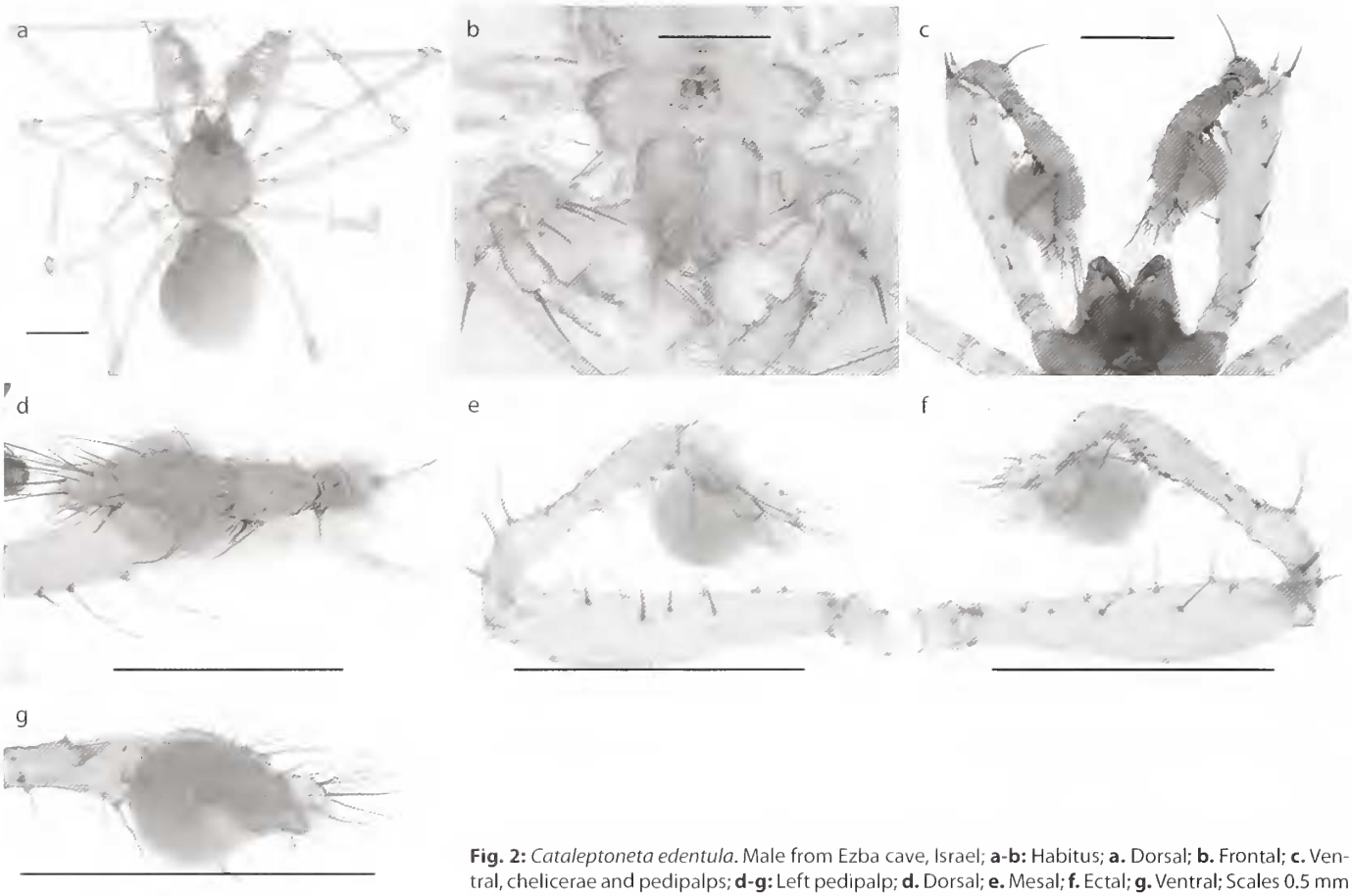

Fig. 2: *Cataleptoneta edentula*. Male from Ezba cave, Israel; **a-b:** Habitus; **a.** Dorsal; **b.** Frontal; **c.** Ventral, chelicerae and pedipalps; **d-g:** Left pedipalp; **d.** Dorsal; **e.** Mesal; **f.** Ectal; **g.** Ventral; Scales 0.5 mm

veral climatic, phytogeographical and zoogeographical zones, as a result of its location on a biogeographical crossroads (Por 1975, Yom-Tov & Tchernov 1988). The three zoogeographical regions that are used for terrestrial animals in Israel are: Palearctic, Palaeoeremic, and Ethiopian, in addition to the Oriental zoogeographical element that has no specific geographical affinity (Por 1975). The Palearctic zoogeographical region includes northern Galilee and is the most widespread zoogeographical element in the Levant. The Palaeoeremic zoogeographical region includes the Negev desert as well as the Jordan valley and the Arava valley. South of the Jezreel Valley, in the north of Israel, and north of the Negev desert are transition zones that includes both Palearctic and Palaeoeremic elements, while the Ethiopian zoogeographical region includes mainly the Jordan valley, the Arava valley, and the coastal plain (Por 1975). Our cave survey aimed at recording the arachnid cave fauna from all of the zoogeographical zones of Israel.

Study sites, material and methods

Between September 2013 and June 2014 we sampled in more than 40 caves in the three zoogeographical regions of Israel: Ethiopian (Jordan Rift valley and Dead Sea valley), Palaeoeremic (Negev desert including the Arava valley) and Palearctic (central and northern Israel including the western mountain ridge (upper Galilee and Judean mountains). The survey was conducted in three different seasons: late summer to autumn, spring, and late spring to early summer. In 33 of the caves we collected arachnids by means of pitfall-traps (with NaCl solution, left in caves for 74-77 days) and hand collecting (with flashlights and UV light); in the rest of the caves only hand collecting was used. Spider collection in nature reserves was conducted under a permit by the Nature and Parks Authorities (No. 2014/40313 for Efrat Gavish-Regev). For the 33 caves (above), spiders were collected at the cave entrance, the intermediate part of the cave (twilight zone) and the dark zone, when it was applicable (some caves were short and did not contain twilight and dark zones). In addition we recorded the physical and climatic attributes of each cave such as length, opening size, elevation, geology, precipitation, temperature, humidity and luminance. Temperature measurements were taken using PicoLite 16-K, a single-trip USB Temperature Logger (FOURTEC), measuring the temperature once an hour during 74-77 days. Illumination was recorded at the time of sampling using an ExTech 401025 Lux light meter. Localities are marked on Fig. 1, and transliterated names of the localities follow the "Israel Touring Map" (1:250,000) and "List of Settlements," published by the Israel Survey, Ministry of Labour. Geographic coordinates are given in WGS84. Elevation, precipitation, and geological data were provided by the GIS (Geographic Information System) center, The Hebrew University of Jerusalem. All specimens collected were transferred into 75 % ethanol. Specimens were examined and illustrated using a Nikon SMZ 25 stereomicroscope, and identified to species when possible using taxonomic literature (Nentwig et al. 2015, World Spider Catalog 2015). Female genitalia were cleared using a 10 % KOH solution. Photographs were taken using NIS-Elements D (Nikon 2015 version 420). Multi-layer pictures were combined using Zerene Stacker (Version 1.04), and edited using GIMP ver. 2.6.10 and Inkscape ver. 0.48. Left structures (pedipalps) are illustrated unless otherwise stated.

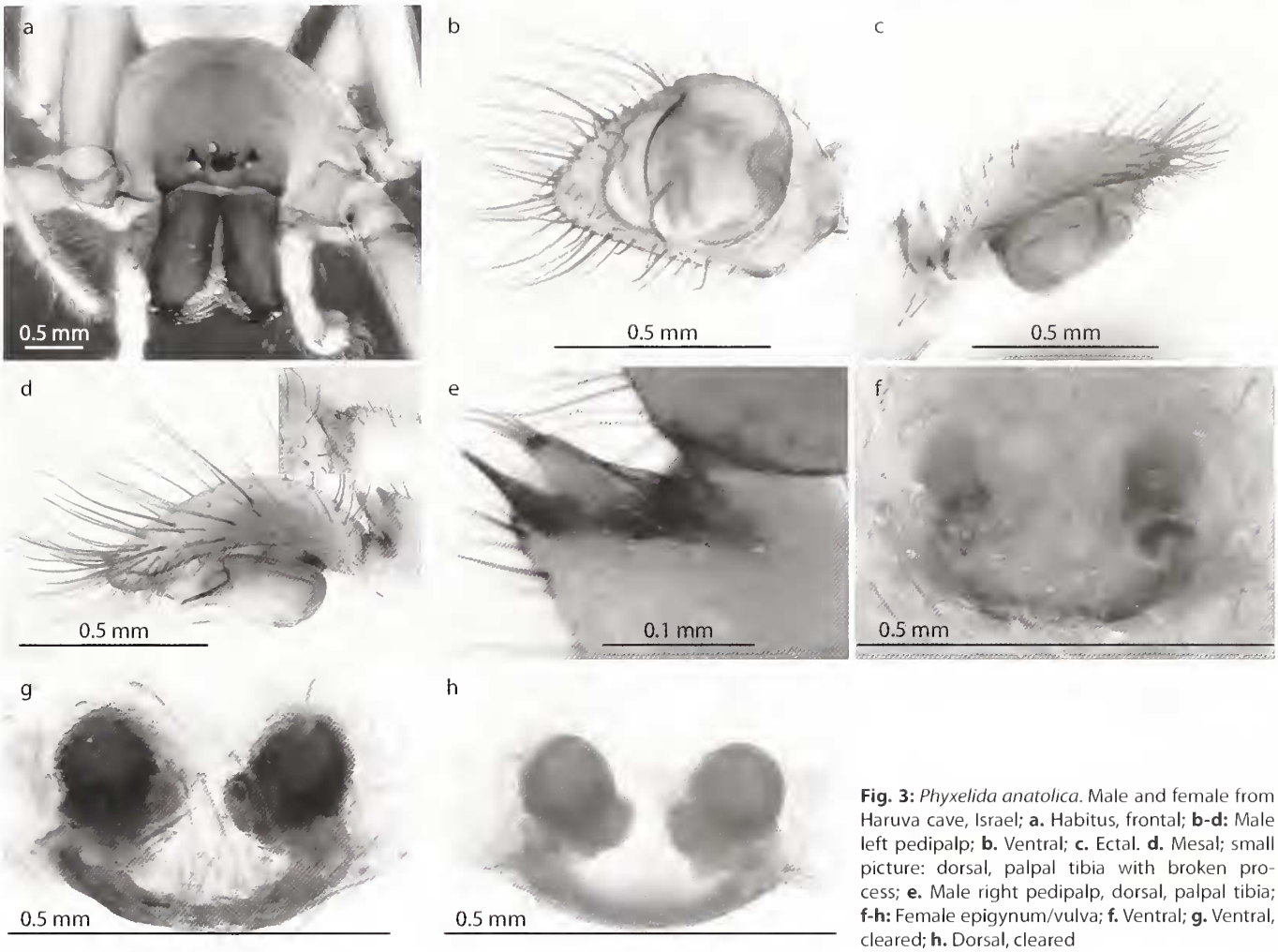

Fig. 3: *Phyxelida anatolica*. Male and female from Haruva cave, Israel; **a.** Habitus, frontal; **b-d:** Male left pedipalp; **b.** Ventral; **c.** Ectal. **d.** Mesal; small picture: dorsal, palpal tibia with broken process; **e.** Male right pedipalp, dorsal, palpal tibia; **f-h:** Female epigynum/vulva; **f.** Ventral; **g.** Ventral, cleared; **h.** Dorsal, cleared

Results

As part of this cave survey we collected one male belonging to the troglophile family Leptonetidae, and more than ten individuals, including an adult male and several females, belonging to the Afrotropical family Phyxelididae (see Fig. 1 for all caves surveyed, and for localities of new records). The overall ranges of elevation, temperature and precipitation (March-June) for all 33 caves, where measurements were taken, included large part of the range found in Israel: -380 to 773 m a.s.l., 7-32 °C and 50-850 mm (March-June), respectively. Yet Leptonetidae and Phyxelididae were found in Israel only in rather temperate caves, with precipitation above 500 mm (details are given below).

Leptonetidae. We found only one male belonging to this troglophile family in the entrance of Ezba cave (32.7118°N, 34.9747°E) on March 13th, 2014. This is a large and rather temperate cave, with a temperature of 14.5 -20 °C (entrance minimum-maximum; March-June 2014). The cave is situated in the Karmel mountain in the north-west of Israel, 120 meter a.s.l., and with yearly average of 650 mm precipitation. The leptonetid spider found in Ezba cave (Fig. 2) belongs to the genus *Cataleptoneta* Denis, 1955, and to the type species of the genus *Cataleptoneta edentula* Denis, 1955, described from a cave in Lebanon and reported thus far only from Lebanon. The spider family Leptonetidae is recorded for the first time in Israel.

Phyxelididae. We found twelve individuals, including three adults (one male and two females) belonging to this Afrotropical family. The specimens were recorded from Haruva cave (31.9133°N, 34.9607°E), as well as from Suseya cave in the West Bank (31.4061°N, 35.1033°E), on March 9th, March 31st, and on August 1st 2014, respectively. Haruva is a large and rather temperate cave, with a temperature of 14.5 - 19.5 °C (entrance minimum-maximum; March-June 2014) and 16 - 19.5 °C (twilight zone minimum-maximum; March-June 2014). Haruva cave is situated in the Judean lowlands in the centre of Israel, 180 meter a.s.l., and with yearly average of 500 mm precipitation. The cave of Suseya is situated in the southern Hebron mountains, part of the Judaean mountains, between the Judean and Negev deserts, at 773 meter a.s.l., and with yearly average of 250 mm precipitation; we did not measure temperatures and illumination in this cave. Although the cave of Suseya is situated in an arid region, the vegetation found in this area, namely semi-steppe batha, includes Mediterranean plants which dominate bathas in more mesic, northern parts of Israel (Danin 2015). This suggests better climatic conditions that can enable the existence of spiders with Palearctic affinities. The phyxelidid spiders found in these caves (Fig. 3) belong to the genus *Phyxelida* Simon, 1894, and to the species *Phyxelida anatolica* Griswold, 1990, described from a cave in southern Turkey, close to Syria, and later reported from Cyprus mountain pine forests (Thaler & Knoflach 1998).

Discussion

Despite more than 35 years of active taxonomical research in arachnology (Lubin & Gavish-Regev 2009, Zonstein & Marusik 2013), it is still common to find new records of known spider species for Israel, and species new to science here. It is less common to find new records of spider families (but see Levy 2003: Anyphaenidae and Hahniidae, Marusik & Zonstein 2011: Synaphridae, and Zonstein et al. 2015: Mysmenidae and Phyxelididae, see below).

Both new family records are known from the Levant sensu stricto: Leptonetidae was reported from Lebanon, and Phyxelididae from Cyprus and southern Turkey not far from northern Israel, where our new records were found. After submitting this short-communication for publication, Phyxelididae was reported from Mount Meron in the upper Galilee and from the Karmel mountain ridge Israel in a paper by Zonstein et al. (2015). Due to the morphological resemblance of the new records from Israel to the known species from the Levant and the localities where they were found in Israel, the recorded species were assigned to the species known from Lebanon and Cyprus and Turkey.

Cataleptoneta edentula, though not presenting any morphological adaptation to life in caves, was recorded thus far only from two caves: the type locality cave in Lebanon and Ezba cave in Israel.

Phyxelida anatolica is the northernmost representative of *Phyxelida*, and was suggested to be restricted to caves (Griswold 1990), however Thaler & Knoflach (1998) suggested it is a hygrophilic or "refugial-cavatic" species, as it was found under stones in pine forest in the Cyprus mountains. Zonstein et al. (2015) recently reported one male and one female, but did not give details of the habitat where the specimens were collected, and stated that the two specimen records are the easternmost and southernmost localities of this species. Here we report two localities that are further south than the previous localities: Haruva cave (31.9133°N, 34.9607°E) and Suseya cave (31.4061°N, 35.1033°E).

Acknowledgements

We wish to thank many colleagues for useful information, discussions and comments and for help with field and laboratory work: Merav Seifan, Marco Isaia, Bernhard Huber, Laibale Friedman, Iris Musli, Amiad Katzover, Adi Ben-Nun, The GIS center and The Cave Research Unit at The Hebrew University of Jerusalem, and especially Boaz Langford and Efraim Cohen. This study was supported by The Israel Taxonomy Initiative (ITI) Biodiversity surveys grant, and by ITI fellowship to SH. This is publication no. 892 of the Mitrani Department of Desert Ecology, Ben-Gurion University, Israel.

References

Danin A 1988 Flora and vegetation of Israel and adjacent areas. In: Yom-Tov Y & Tchernov E (eds.) The zoogeography of Israel. Junk, Dordrecht. pp. 129-159

Danin A 2015 Flora of Israel online. – Internet: http://flora.org.il/en/books/vegetation-of-israel-and-neighboring-countries/chapter-a/local_veg_a7/ (October 25, 2015)

Deltshev C, Ćurčić B, Wang C, Yao Z, Antić D, Ćurčić S & Rađa T 2014 New data on the spiders (Araneae) in the caves of Balkan Peninsula. – Archives of Biological Sciences 66: 465-471 – doi: 10.2298/ABS1402465D

Deltshev C 1985 New data concerning cave spiders (Araneae) in Greece with description of a new *Leptonetela* (Araneae, Leptonetidae) . – Acta Zoologica Bulgarica 27: 41-45

Denis J 1955 Araignées. In: Mission Henri Coiffait au Liban (1951). – Archives de Zoologie Expérimentale et Générale 91(Biospeologica 75): 437-454

Griswold CE 1990 A revision and phylogenetic analysis of the spider subfamily Phyxelidinae (Araneae, Amaurobiidae). – Bulletin of the American Museum of Natural History 196: 1-206

Jocqué R & Dippenaar-Schoeman AS 2006 Spider families of the world. Musée Royal de l'Afrique Central, Tervuren. 336 pp.

Ledford J 2004 A revision of the spider genus *Calileptoneta* Platnick (Araneae, Leptonetidae), with notes on morphology, natural history and biogeography. – Journal of Arachnology 32: 231-269 – doi: 10.1636/H02-41

Ledford J, Paquin P, Cokendolpher J, Campbell J & Griswold C 2011 Systematics of the spider genus *Neoleptoneta* Brignoli, 1972 (Araneae: Leptonetidae) with a discussion of the morphology and relationships for the North American Leptonetidae. – Invertebrate Systematics 25: 334-388 – doi: 10.1071/IS11014

Levy G 2003 Spiders of the families Anyphaenidae, Hahniidae, Ctenidae, Zoridae, and Hersiliidae (Araneae) from Israel. – Israel Journal of Zoology 49: 1-31 – doi: 10.1560/X05J-T0MU-UL4A-8RLQ

Lubin Y & Gavish-Regev E 2009 In memoriam Gershom Levy (1937–2009). – Israel Journal of Entomology 38: 133-142

Marusik YM & Zonstein S 2011 A synopsis of east-Mediterranean *Synaphris* Simon, 1894 (Araneae, Synaphridae) with a description of a new species from Israel. – ZooKeys 82: 35-44 – doi: 10.3897/zookeys.82.957

Nentwig W, Blick T, Gloor D, Hänggi A & Kropf C 2015 Spiders of Europe, version 10.2015. – Internet: http://www.araneae.unibe.ch (October 25, 2015)

Por D 1975 An outline of the zoogeography of the Levant. – Zoologica Scripta 4: 5-20 – doi: 10.1111/j.1463-6409.1975.tb00713.x

Reddell JR 2005 Spiders and related groups. In: Culver DC & White WB (eds.) Encyclopedia of caves. Elsevier Academic Press, Burlington. pp. 554-564

Romero A 2009 Cave biology: life in darkness. Cambridge University Press, Cambridge, UK. 306 pp.

Sket B 2008 Can we agree on an ecological classification of subterranean animals? – Journal of Natural History 42: 1549-1563 – doi: 10.1080/00222930801995762

Thaler K & Knoflach B 1998 *Phyxelida anatolica* Griswold, new to Cyprus (Arachnida Araneae: Amaurobiidae, Phyxelidinae). – Bulletin of the British arachnological Society 11: 36-40

Trajano E 2005 Evolution of lineages. In: Culver DC & White WB (eds.) Encyclopedia of caves. Elsevier Academic Press, Burlington. pp. 230-234

World Spider Catalog 2015 World spider catalog, version 16.5. Natural History Museum, Bern. – Internet: http://wsc.nmbe.ch (October 25, 2015)

Yom-Tov Y & Tchernov E 1988 The zoogeography of Israel. The distribution and abundance at a zoogeographical crossroad. Junk, Dordrecht. 600 pp.

Zonstein S & Marusik YM 2013 Checklist of the spiders (Araneae) of Israel. – Zootaxa 3671: 1-127 – doi: 10.11646/zootaxa.3671.1.1

Zonstein S, Marusik YM & Omelko M 2015 A survey of spider taxa new to Israel (Arachnida: Araneae). – Zoology in the Middle East 61: 372-385 – doi: 10.1080/09397140.2015.1095525